Diabetes Mellitus Type 2: Prevalence rate and risk factors contributing to the spread of diabetes mellitus in Ar Raqqa Governorate - Syria

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Abstract:

Background: *Although there is an observed increase in incidence rate of diabetes mellitus, there are no previous studies conducted in Ar Raqqa governorate to assess the actual prevalence of diabetes mellitus and the main risk factors related to this disease.*

Aim & objective: *the primary aim of this research was to identify the prevalence of type 2 diabetes mellitus in Ar Raqqa governorate to develop recommendations for a health awareness campaign and prevention program with regards to diabetes mellitus in Ar Raqqa governorate and to prepare national guidelines for prevention and control of diabetes.*

Setting: *Ar Raqqa governorate - Syria.*

Methods: *The research team surveyed 72 households (586 individuals) in 2010. The multi-stage sampling method was applied. The governorate was divided into two major parts (city and countryside). Cluster sampling was considered after dividing the city into several building groups. The countryside was divided according to the districts of the governorate. Systematic random sampling was applied. The risk factors related to diabetes mellitus were assessed to impact of these factors on the development of diabetes mellitus. Diabetes mellitus in this study refers to type 2 diabetes mellitus.*

Results: *Using PASW software program for data entry and analysis, the principal risk factors of diabetes mellitus in Ar Raqqa governorate were; Obesity, lifestyle and physical activity, hypertension, age, food intake and health awareness were contributed to the development of diabetes mellitus. The prevalence rate of type 2 diabetes mellitus amongst the target group was 18.3%. This rate varied between three clusters of residency; city center, informal residency neighborhoods inside the city, and rural areas. Before the survey, the majority of type 2 diabetic patients did not know that they have diabetes mellitus, and they were consulted and referred to the public clinics of diabetes in the city.*

Index Terms: *(diabetes, urbanization, obesity, prevalence, factors, Syria, Raqqa)*

I. Introduction

Diabetes mellitus is a public health concern that has a global health and socio-economic impact in developing and developed countries [1]. Diabetes mellitus (DM) is set to become one of the world's most important health issues facing the nations due to the increase in new diabetic cases [2].

It has been estimated that the prevalence of DM in adults worldwide was 4% in 1995. The prevalence rate is anticipated to increase to 5.4% by the year 2025. The figures of DM are continuously changing, and it is expected that the number of DM cases among adults in the world will increase from 135 million in 1995 to 300 million in the year 2025, and the significant increase will occur in developing countries. Numerically, the increase in developing countries will be 170%, and as a result, the number of DM cases will reach 228 million [3].

The overwhelming influence of diabetes on families resides in the consequential losses for every diabetic patient in society. These mechanisms which represent this losing include costs for complications treatment, medical care and support of the disabled individuals, and self-reliance that ultimately lead to all economic development and growth [4].

The economic burden can be diminished by implementing many inexpensive, easy-to-use preventive interventions, most of which are cost-effective or cost-saving, even in the most deprived income countries. Nonetheless, these preventive interventions are not widely conducted in low- and middle-income countries nowadays [5].

A study was conducted in Syria to estimate the cost of 200.000 diabetic patients' complication management and treatment (200.000 = 10% of total Syrian population which is at the same time the suggested DM prevalence in Syria). The estimated cost was approximately about 242% of Syrian budget allocated for health [6].

In a meeting with Dr. Bilal Hammad, the director of the National Diabetes Program in Syria, he mentioned that the number of diabetic cases was noticeably increased, and Ar Raqqa governorate has reached a higher level of urbanization within a short period with remarkable increasing in urban areas population. He said, "Although the current level of urbanization in Ar Raqqa is far away from Aleppo or Damascus, the current indicators of DM in Ar Raqqa are similar to them in these cities. "

II. Review of The Literature

Diabetes Mellitus DM: According to the World Health Organization (WHO) definition of DM, this disease is a metabolic disorder that results in due to defects in insulin secretion, action, or both. DM is mainly characterized by chronic hyperglycemia and metabolic disorders related to the carbohydrate, fat, and protein [7].

- Classification of Diabetes Mellitus

Scobie has classified DM into two main types:

- Type 1 diabetes mellitus T1DM: or Insulin Dependent Diabetes Mellitus IDDM. This type is characterized by insulin deficiency due to a destruction that affects ß cells in the pancreas. T1DM is often described by juvenile onset.

- Type 2 diabetes mellitus T2DM: or Non-Insulin Dependent Diabetes Mellitus NIDDM. This type is often caused by several risk factors such as obesity, hypertension, and lifestyle. T2DM is described by later in life onset. However, current studies have indicated to T2DM with a juvenile onset. There is no insulin deficiency in T2DM, and the problem lays behind the insulin resistance in the body [2].

- Type 2 Diabetes Mellitus Diagnostic Criteria:

T2DM is characterized by mild sever but insidious onset. In addition, type 2 diabetic patients are not in need for daily insulin injections [8].

According to Asian-Pacific Type 2 Diabetes Policy Group, T2DM has been considered to be on the top of the most crucial health issues challenging the current health systems in the world. The prevalence of T2DM has been recorded annual gradual elevation. However, developing countries will face a considerable burden of this disease due to a combination of several factors including the lack of related studies regarding DM and risk factors that aim to strengthen the health system [9].

The most common risk factors interacted with the development of DM are; high blood glucose, obesity, high blood pressure, dyslipidemia, physical inactivity and sedentary lifestyles, socioeconomic status SES, race, lack of health education, low level of awareness, and smoking [10].

Obesity is represented by the measurement of body mass index BMI. The majorities of adults with (BMI) measured more than 30 often suffer from accompanied presentation such as hypertension, dyslipidemia, and T2DM [11].

According to WHO, hypertension is considered to be a common co-morbid risk factor affecting a high percentage of diabetic patients. Studies about hypertension as a risk factor for DM indicate that 20%- 60% is the percentage of diabetic patients who suffer from hypertension [10].

Ageing also plays an important factor affecting the onset of T2DM. The age of onset of T2DM usually occurs after the age of 40 years. However, due to changes in lifestyles and eating habits and the fast moving toward urbanization, recently, there is a possibility to diagnose T2DM decades earlier in populations with high prevalence of DM. In addition, the level of parental education at baseline was associated with a subsequent escalate of DM prevalence as it is related to the physical inactivity [12].

Similar to the neighboring countries, obesity in Syria is considered as a significant risk factor for DM. A study that was conducted in Syria – Damascus showed that the prevalence of obesity was 35% among people older than 18. In two studies which were carried out in 2009, the prevalence of hyperlipidemia in people with T2DM was found to be around 20%. Diabetes is progressively spreading in Syria and its neighboring countries due to dramatic changes in lifestyles and nutritional habits [13]. A conducted study in Aleppo in 2010 indicated that the prevalence of T2DM was higher among the elders. Similarly, the prevalence of obesity was higher among females than males (58.3% and 36.6% respectively). The overall prevalence of T2DM was 47.7%. The prevalence of T2DM was 33.5% among those who were >45 age, while it was 3.5% among (25-45) age group, and BMI was significantly associated with T2DM development. Among those who had normal weight (BMI<25), the prevalence of DM was 4.6%. However, it was 13% among overweight individuals (25≤BMI<30). The prevalence of T2DM among obese subjects (BMI≥30) was 22.4%. Furthermore, physical inactivity and a history of diagnosed T2DM among relatives were also significantly associated with T2DM. The prevalence of T2DM among individuals who have reported a history of T2DM among relatives was 23.4% compared to 10.5%. Among those with a low level of physical activity, the prevalence of T2DM is 17.4% compared to 7%. The level of socioeconomic status (SES) was also significantly associated with the prevalence of T2DM. Subjects were divided among three groups depending on SES level (low, middle and high level of SES). The prevalence rates of T2DM were respectively (20.3%, 11.8%, and 12%). The study has concluded that age, BMI, family history of T2DM, and SES level were the major risk factors for T2DM in Aleppo [14].

DM is still keeping pace with the developing urbanization in Syria as a developing country, and there is a critical need to estimate the real impact of DM in Syria. Although there are various announcements about the prevalence of DM in Syria, there is no specific rate to be based on when assessing the prevalence of diabetes in Syria. Dr. Gazi Niazi the director of Syrian diabetes association (SDA) mentioned that the prevalence of DM in Syria is higher than 12% [15].

III. Material, Methodology, and Methods

A. *Research Methodology*

The study was conducted in 2010 to identify the prevalence of DM in Ar Raqqa city, and the main risk factors that are contributing to the development of the disease. A survey was conducted to collect the necessary data to achieve the objectives of the study.

As this study was directed to measure the actual prevalence of a specific health issue (DM) among the defined population (Ar Raqqa population) and the relevant risk factors, the best design to achieve this goal was a cross-sectional survey or prevalence survey [16]. The research was a descriptive study as it was conducted to describe the disease at the time of the study. Data were collected through a survey and were divided among several variables which were out of the researcher control. In addition, this survey attempted to describe a specific phenomenon and the main relevant risk factors. Hence, this survey was considered as an ex post facto research [17]. According to IDF, the standardized prevalence of T2DM in Syria in 2007 was 10.6% within the age group of (20-79) [18].

B. *Research Setting*

Ar Raqqa governorate - Syria

C. *Sample Design*

I. Type of universe: The type of the universe (population) is finite, which is the total number of Ar Raqqa governorate population. We depended on the issuance of the Statistical Abstract for 2009 from CBS in Syria to determine the total number of Ar Raqqa governorate population (residents), which was 887,000 in the June 31st, 2009. (467,000= 52.64% males and 420,000= 47.36% females). The total number of residents the rural areas was 544,000 (61.33%), while it was 343,000 (38.67%) in urban areas of the city [19]. Al-Thawra city was not involved in the study as it is considered as another city within Ar Raqqa governorate and it is similar to Ar Raqqa city in term of demographical, health status, and rural background.

II. Sampling unit: this survey was conducted on several families. Blood samples and questionnaires were carried out on

households. Therefore, sampling unit was a social unit (household) [17].

III. Sampling frame: There was no source list from which the sample had to be selected. There was no source list contains the name of all families of the universe. Therefore, a source list was prepared. There was a map for the building blocks in Ar Raqqa city (organizational map of Ar Raqqa city). However, the number of households in each group was unknown. Thus, the number of building and houses in each block was counted. The total number of households was a numeric source list of each buildings block. The rural areas were considered as a separate cluster. Targeted houses were determined using the systematic random sampling method using a list of Ar Raqqa governorate villages with the total number of population of each village. The number of families amongst each village was estimated by dividing total population number on the value of the average number of rural family members.

IV. Size of Sample: this was calculated using statcalc software program using the 2009 estimation of Ar Raqqa governorate population size and relying on the percentage of 10.6% as the prevalence of DM according to the estimation of IDF [18]. In principle, the study group was compromised of 300 individuals. Nonetheless, as the sampling method is a multistage stratified cluster, the final number of individuals was 300 X 2 = 600. To make the sample representative and proportional, 360 and 240 subjects were selected from the countryside and city respectively. The sampling unit was a family, and hence, the number of households to be involved in this study was calculated. In Ar Raqqa governorate, the mean of about 90% of Ar Raqqa city family members is 7.5 members\family, and 10 members\family among Ar Raqqa countryside [20]. Therefore, the sample size was 72 units. 36 units were chosen from the countryside, and 36 units from the city.

V. Sample type: The probability proportional multistage stratified cluster sampling was applied since the total area of the survey is extensive. The borders of each cluster in Ar Raqqa governorate were set according to CBS standards, and the subjects among each cluster were proportional to the size of the cluster.

D. Research Subjects, Recruitment, and Consent

- Research Subjects: It is evident that recently T2DM has been diagnosed even amongst young adolescents, especially among the vulnerable population [2]. To achieve reliable and accurate results, the participants were from all age levels. The study group individuals were divided into the following age groups (1: 7-19, 2: 20-39, 3: 40-59, 4: 60-79). Because it is very complicated to deal with children especially with an invasive procedure (blood sample taking), individuals of less than seven years old were excluded.
- Recruitment and Consent: Participants were involved in this study according to the sample type. After identifying households, participants were asked to be involved in this study.

E. Data Storage: Confidentiality and Privacy

The privacy and confidentiality for every participant were guaranteed by a written statement in the consent form. The personal data were stored using private files stored in save place. Only the research team was authorized to have access to the data. Moreover, to guarantee the privacy and accuracy of females provided data, the survey procedures were conducted amongst two separated rooms, and two female volunteers carried out the questionnaire and took the blood samples from the female subject. Nevertheless, several families did not accept to perform this separation between males and females. Therefore, females' questionnaires were done by the female volunteers and were not submitted to the researcher in front of the family members to prevent them from knowing the answers of the female members of the household.

F. Ethical Aspects and Consequences of The Subjects

1- Ethical Aspects:

The required permits to conduct the project were taken from the Syria Ministry of Health. A written permit has been obtained from the health directorate in Ar Raqqa, and all the government health facilities were available for any required laboratory test for the research. Additionally, local councils and police centers of the districts in the countryside have been informed by the researcher about the survey for any possible communication regarding the survey and visits. Liverpool School of Tropical Medicine in UK and the Centre for Strategic Health Studies CSHS in Damascus have authorized the researcher to conduct the study.

2- Consequences for the Subjects:

All personal information was not saved and not used for any other unscientific purposes. Subjects with positive blood glucose test have been informed about the result and given a consult how to get registered in the public clinics of diabetes to receive treatment.

The blood glucose test is an invasive test. Hence, it was essential to ensure the using of disposable needles.

G. Definition of Used Instruments

In addition to the disposable needles and anti-clot (Heparin) blood tubes which were used during blood sample collection and preservation, there was the manual (not digital) manometer to measure the blood pressure. Furthermore, there was the laboratory device (Hitachi) by which the blood tests were performed. Similar devices were utilized to perform the blood test in other governmental healthcare facilities in Ar Raqqa governorate.

H. Survey Methods

1- Age: the participants were divided using two methods of categorization. The first grouping was; (7-19) and (20-79) in order to study the relationship between T2DM with the attributed risk factors, and the other grouping was; (7-19), (20-39), (40-59), (60-79) for more detailed information regarding the age.

2- Body Mass Index BMI and Waist Circumference WC (Central Obesity): recent definitions of obesity are established upon the ratio of body weight (in kg) and height squared (in m2) Kg/m2, and defined as body mass index (BMI) with a normal BMI (20–24.9), moderate overweight (25–29.9), and obesity as ≥30 [11]. Therefore, body weight and height were measured to the nearest 0.1kg and 0.1cm respectively, using standardized equipment and procedures. The waist circumference WC was measured to the nearest 0.1cm, midway between the last rib and the iliac crest.

3- Smoking: participants were categorized into 1- Non-smoker. 2- Ex-smoker. 3- Current smoker: (≤20 cigarettes per day or >20 cigarettes per day). Those who smoke Narghile regularly were considered as current smokers >20 cigarettes per day.

4- Sedentary lifestyle (Physical activity): sedentary lifestyle is considered to be a critical issue pertinent to obesity and diabetes. Relaxing inactivity such as spending much time watching TV and computer games were related high levels of BMI among children of 9–14 years. Furthermore, among girls, physical inactivity was related to an increase in BMI [21]. To assess the physical activity, we calculated person's Physical Activity Level (PAL), which describes the person's Total Daily Energy Expenditure (TDEE). In other words, it is a number that refers to the performed activities per day. In addition, PAL takes into consideration the Basal Metabolic Rate (BMR). The equation of PAL is: PAL = TDEE/BMR

4-1- BMR value was calculated depending on Harris-Benedict equation. Accurate measurement of BMR depends on weight (kg), height (cm), and age (year).

$$BMR = (13.75 \times w) + (5 \times h) - (6.76 \times a) + 66 \quad (1)$$

$$BMR = (9.56 \times w) + (1.85 \times h) - (4.68 \times a) + 655 \quad (2)$$

'Equation 1 is to calculate the value of BMR for men.'
'Equation 2 is to calculate the value of BMR for women.'
w: weight, h: height, a: age

4-2- TDEE: accurate measurement of TDEE depends on the person's weight and lifestyle. Lifestyles are classified among three types according to exercises practicing, kind of job, and other relevant factors. The kind of job was assessed through the questionnaire which was modified and consisted of several questions in order to explore:

4-2-1- Activities at home: TV or video watching habit, stair climbing, activities in and around the home.

4-2-2- Activities at work: work hours per day, the pattern of job and activity level during work hours.

4-2-3- Recreation: spending leisure time.

$$TDEE = weight\ in\ pound \times 14 \quad (3)$$

$$TDEE = weight\ in\ pound \times 17 \quad (4)$$

$$TDEE = weight\ in\ pound \times 20 \quad (5)$$

Equation 3 is to calculate the value of TDEE for sedentary people (office workers, rare exercises).
Equation 4 is to calculate the value of TDEE for moderately active people (construction workers and those who play sports 3 to 5 times a week).
Equation 5 is to calculate the value of TDEE for active people (agriculture workers, those who play sports on daily basis).

The values of BMR and TDEE were calculated and replaced in the PAL equation. According to PAL values, subjects were categorized among five categories: 1: Inactive (<1.4). 2: Sedentary (1.4-1.69). 3: Moderately active (1.7-1.99). 4: Vigorously active (2-2.4). 5: Extremely active (>2.4) [22].

5- Endogamy: parents were asked if they are relatives or not, and they were asked if parents of each of them were relatives.

6- Educational Level of parents: The level of education was taken for each of the parents, and the educational level of those who were students were taken relevantly to their level at the time of research. The participants were categorized -according to the educational level of the father and mother separately- into four main categories: 1- Primary education (elementary and preliminary degree). 2- Secondary education. 3- Intermediate education or current intermediate institute student (intermediate institute degree). 4- High education or current student in a college (college degree and above).

7- Socioeconomic Status SES: Referring to a conducted study in Syria regarding the monthly income of families [23], target households have been divided into five categories according to the SES level: 1- class 1: (≤10509 SP). 2: class 2 (10510-14491 SP). 3: class 3 (14492-19181 SP). 4: class 4 (19182-27890 SP). 5: class 5 (≥27891 SP).

8- Family History of diabetes: The participants were categorized into two main variables: A family history of diabetes amongst first-degree relatives (parents, brothers, sisters, grandfather, and grandmother), and; a family history of diabetes amongst second-degree relatives (aunt, uncle, brother and sister in law, and father and mother in law).

9- Food intake: the assessment of food intake was based on the number of daily meals and if the subject is used to have snacks, fast food, or to have an unorganized schedule of meals on a daily basis.

10- HDL Cholesterol and Triglycerides Concentration (Hyperlipidemia): according to the National Institute of Health (NIH), individuals with HDL <35mg/dL and triglycerides >250mg/dL will be diagnosed with hyperlipidemia (abnormal lipid levels) [24]. On this regard, participants were divided into two variables: hyperlipidemia, and non-hyperlipidemic.

11- Blood Pressure BP: the majority of studies consider that a blood pressure of (140/90mm/Hg) confirm the diagnosis of hypertension [25]. The participants were classified into two categories depending on whether the participant suffers from hypertension or not. 1- Hypertension subjects. 2- Non-hypertension subjects.

12- Self-health care: depending on whether the family made the determined call contact or not, the participants were divided to 1- interested in the self-health status, 2- not interested in the self-health status. This variable has been added to assess the self-health care of the participant.

13- Blood Glucose Level: WHO criteria to diagnose DM was applied to confirm the diagnosis of DM; fasting plasma glucose FPG of ≥126 mg/dL (7mmol/L) confirms the diagnosis, and 110-125 mg/dl confirms an impaired glucose tolerance case [10]. The subjects were categorized according to fasting blood glucose test; 1- non-diabetic patient, 2- T2DM.

I. Quality Assurance

Regarding the questionnaire administration, the procedure was conducted through face to face interviews. The participants were asked whether they had been fasting for 8 hours or not before taking the blood samples. Subject who had not been fasting for 8 hours were excluded.

J. Data Collection and Survey Procedures:

The period of data collection was from the 9th of December 2010 until the 9th of January 2011. The field teamwork consisted of a public health researcher, a second-year student in a medical laboratory in Ar Raqqa public hospital, a general dentist to measure BP for participants, two female volunteers to administer the questionnaires and to take blood samples from the female subjects. Three meetings between team members were done to train the female volunteers how to perform the questionnaire. Furthermore, every female questionnaire was reviewed by the public health researcher before leaving the targeted household. Males' questionnaires were performed by the public health researcher. Ar Raqqa city was divided into 24

clusters based on the administrative clustering of CBS in Ar Raqqa, and the countryside was considered as a separate cluster. The target households were selected by counting households in each cluster until we reach the sample interval. Research aim and objectives were orally explained to the head of the household besides the survey procedures. Moreover, the parents had to read the written consent form and sign in case of approving it. The mobile or telephone number was recorded beside the name of the household head to make a call contact 30 minutes before the identified household visit. For every household, the visit for taking data and blood samples was determined on the day after getting the consent from the household. The appropriate instruction regarding the 8-10 fasting hours before the visit was seriously explained to the household to guarantee the accuracy of the blood test results. On average, four daily visits were performed amongst city, and three amongst countryside. The first visit ranged between 6.00 to 7.00 AM. The heads of households were contacted 15-30 minutes before the determined time of the visit to be ready. The time of each household visit was between 45 to 60 minutes. Blood samples were preserved into anti-clotting tubes. Every tube was given an identification number similar to the number of participant's questionnaire (ID number). The first name of each subject has been recorded on paper with other ID numbers of the same household subjects. The paper was submitted to the household after an oral explaining that they would be informed about their blood test results according to their ID numbers by calling a mobile number that was written on this paper. The date of this phone contact was determined and written by the public health researcher besides a verbal confirmation about this date. After each visit in the city, the team went back to the central laboratory in Ar Raqqa National Hospital to perform the blood samples sedimentation. The plasma was preserved in tubes (4 C°) that were numbered according to the ID numbers of the subjects. After the daily visits, the team started to the procedures of blood samples test using the plasma tests device (Hitachi). The results were immediately recorded and printed. The results were recorded and printed out to be stored according to the ID numbers of each household.

Household visits included the measurement of height (cm), weight (approximated kg), and waist circumference (cm). Blood pressure was measured and recorded for the subjects, and blood samples were taking was performed after measuring the BP.

IV. Results:

Data entry and analysis was performed using a software computer analytic program by which the results were expressed (PASW v.18). A total of 586 participants distributed in 72 families were involved in this study. The total number of families in the city was 36 (238 subjects), and 19 families (156 subjects) of them were in the peripheral clusters (informal residential zones), and 17 families (82 subjects) were among the central clusters. The number of rural residential families was 36 families (348 subjects). Table 1 expresses the descriptive analysis regarding the distribution of families amongst clusters in addition to the gender of subjects and related percentages. While the average number of household members in the central area of the city was 4.8, it was 8.2 and 9.6 for households in peripheral areas of the city and countryside respectively, which are relatively very close. Therefore, the study considered the central and peripheral areas of the city as separate clusters due to the expected variation between the two clusters in term of lifestyle, awareness, social norms and culture.

Table 1: the distribution of participants amongst the clusters position and gender:

	Ar Raqqa governorate		Urban		Rural	
Total subjects	586		238		348	
No. Families	72		36		36	
Gender	Male: 259	Female: 327	Male: 106	Female: 132	Male: 153	Female: 195
(%)	44.2%	55.8%	44.5%	55.5%	44%	56%

Table 2: the distribution of participants amongst the four age groups and gender

		Gender		Total
		Male	Female	
Age Group	7 – 19 yrs	100 (39.2%)	119 (36.8%)	219 (37.9%)
	20 – 39 yrs	76 (29.8%)	105 (32.5%)	181 (31.3%)
	40 – 59 yrs	54 (21.2%)	75 (23.2%)	129 (22.3%)
	60 – 79 yrs	25 (9.8%)	24 (7.4%)	49 (8.5%)
Total		255	323	578* (100%)

* 8 missing values.

The participants were divided into four age groups. The majority of the participants were among the first age group. 8.5% of the participants were among the last age group. Furthermore, another division of participants regarding age was performed as we aimed to determine the prevalence of type 2 diabetes mellitus amongst (20-79) age group. The distribution of participants regarding gender and age groups is expressed in table 2.

The mean age of participants amongst (7-19) age group was 12.7, while it was 40.5 for participants amongst (20-79) age group. The total number of smokers was 106 (28.9%), and 27 (7.4%) participants were previous smokers.

The majority of the participants were illiterates, 184 (31.4%) of participants were not able to read or write. Moreover, 168 (28.7%) of the participants had the primary or preliminary educational degree. 25 (4.3%) of the participants had completed the secondary level, and 20 (3.4%) of them had an intermediate institute degree or was a student in an intermediate institute. The overall number of participants who had an academic degree or were collegiate students more was 14 (2.4%). The educational levels are mentioned in the paragraph of survey methods. In a relevant issue, amongst all families, no one of the participants' mother had an academic degree.

Participants were divided amongst five main categories depending on their level of physical activity after calculating PAL values. Although Ar Raqqa governorate is described as an agricultural region, and the majority of individuals amongst

rural areas work in the agriculture field, even females. Fourteen subjects (4.2% of total subjects amongst rural clusters and 2.3% of total subjects) in the countryside were classified as extremely active persons. Additionally, three subjects amongst peripheral clusters and only one person among central city were classified as extremely active. These results support the recent fact about the gradual tendency of the majority of Ar Raqqa governorate population to urbanization's habits. Table 3 expresses the distribution of the participants within the five categories of physical activity level.

Table 3: the distribution of participants amongst PAL categories and cluster position

		Cluster position			Total
		Central	Peripheral	Rural	
PAL Categories	Inactive	28 (34.6%)	40 (26.1%)	96 (28.7%)	164 (28.9%)
	Sedentary	22 (27.2%)	47 (30.7%)	95 (28.4&)	164 (28.9%)
	Moderately active	23 (28.4%)	43 (28.1%)	75 (22.5%)	141 (24.8%)
	Vigorously active	7 (8.6%)	20 (13.1%)	54 (16.2%)	81 (14.3%)
	Extremely active	1 (1.2%)	3 (2%)	14 (4.2%)	18 (3.2%)
	TOTAL	81	334	153	568

The percentages are based on the cluster residents.

- Prevalence of type 2 diabetes mellitus:

The prevalence of T2DM amongst the age groups was identified. Furthermore, the prevalence amongst the main three categorical distribution of age within the (20-79) was identified as well. The prevalence of T2DM amongst (20-79) age group in Ar Raqqa governorate was 18.3%, and 10.4% of diabetic patients were not aware of the high level of blood glucose. This value varied between city and countryside on the one hand, and between cluster positions on the other hand. The prevalence of DM was 20% among city, and 17.4% among the countryside.

The prevalence of T2DM was 14.8% among the central clusters, and 23% amongst peripheral clusters of the city. The majority of the diabetic patients were among (40-59) age group (62.7% of the total T2DM patients). 26.9% of the cases were among (60-79) age group, and 10.4% of the cases were among (20-39) age group (table 4).

Table 4: prevalence of T2DM distributed according to the place of residence and age groups.

		Age group			Total
		20-39	40-59	60-79	
Resident Place	Central	1 (0.5%)* (0.2%)**	2 (1.5%) (0.5%)	4 (8.1%) (1.1%)	7 (14.8% of Central residents)
	Peripheral	4 (2.2%) (1.1%)	16 (12.4%) (4.3%)	3 (6.1%) (0.8%)	23 (23% of slam residents)
	Rural	2 (1.1%) (0.5%)	24 (18.6%) (6.5%)	11 (22.4%) (3%)	37 (17.4% of Rural residents)
Total		7 (3.8%)	42 (32.5%)	18 (36.7%)	67 (18.3%) of total subjects

* Upper percentages refer to the percentage of T2DM subjects within the total subjects of the age group.
** Lower percentages refer to the percentage of IFG subjects within the total (20-79) age group subjects.

The majority of type 2 diabetic patients (48.1%) were not aware of the presence of abnormal glucose levels in their blood, and they were not aware that they are diabetic patients. When we tested the association between T2DM and residency status (urban and rural), and between T2DM and position of clusters of the city (central and peripheral), we found that there is no significant relationship between these variables, $\rho = 0.473$, $0.831 > 0.05$ respectively. This result supports the hypothesis of this research that there is a remarkable impact of urbanization on Ar Raqqa governorate, even in rural areas. There are several variables in this study which reflect the level of urbanization such as SES, educational level, PAL, lifestyle, and food intake pattern. Therefore, we attempted to identify the variables by which Ar Raqqa governorate in general and both rural area and peripheral clusters were affected. The general assumption for any research about the epidemiology of T2DM is the reverse correlation between PAL and nutrition pattern (NP), and urbanization, especially in developing countries where there is a tendency to a sedentary lifestyle and westernized food intake pattern amongst cities population [26]. In other words, it is supposed that there is a significant relationship between the residency place (city or countryside), and PAL and NP. Nevertheless, In Ar Raqqa governorate there was no correlation between these variables. The multinomial regression between the resident place in term of urban and rural and the five categories of physical activity level showed an absence of the assumed relationship. Likewise, when we tested the relationship between the resident place and NP categories, we found no significant relationship between the two variables. Table 5, 6 expressed the type of the relationship between the resident place and PAL, and between the resident place and NP respectively depending on ρ value.

Table 5: ρ values of the relationship between resident place and PAL

		ρ value
PAL	1: Inactive	0.17> 0.05
	2: Sedentary	0.123> 0.05
	3: Moderately active	0.113> 0.05
	4: Vigorously active	0.057> 0.05
	5: Extremely active	0.362> 0.05

Table 6: ρ values of the relationship between resident place and NP

		ρ value
NP	1: Healthy NP	<0.05
	2: Normal NP	0.08 >0.05
	3: Unhealthy NP	0.142 >0.05

As expected, the prevalence of T2DM was higher amongst people who were classified as low level of physical activity depending on their lifestyle LS. Furthermore, nutrition pattern shows a significant relationship with T2DM development and progress (table 7).

Table 7: relationship between T2DM and (LS & NP)

		ρ value	Odds ratio	CI (95%)	
				Lower	Upper
LS	Inactive (Sedentary)	< 0.05	Reference		
	Moderately active	< 0.05	0.37	0.19	0.73
	Extremely active	< 0.05	0.32	0.17	0.61
NP	Healthy NP	< 0.05	Reference		
	Normal NP	< 0.05	2.25	0.64	7.9
	Unhealthy NP	< 0.05	3.41	0.1	11.7

The results reflected a significant relationship between DM and obesity. The prevalence of obesity based on BMI criteria was 34.4% amongst the sample. Likewise, there was a remarkable value of overweight percentage 32%, while the percentage of normal weight subjects was 33.6% which is less than the value of obesity prevalence. Moreover, among the rural population, the prevalence of obesity (32.7%) was very close to the prevalence of obesity among urban population (36.9%). Similarly, the values of overweight prevalence within the urban and rural population were close (32.9%, 31.3% respectively). These findings gave additional support to the research's theory about the gradual absence of gaps between city and countryside regarding food intake pattern and its consequences on individuals especially the obesity. Obesity was classified as the leading risk factor among type 2 diabetic patients. Obesity can be described as an epidemic in Ar Raqqa governorate. In fact, the probability of having DM is increasing with the high levels of BMI. Table 8 contains the relationship between BMI and T2DM. This fact supported the theory that there is a rapid movement amongst Ar Raqqa population towards urbanization.

Findings of this study apparently referred to the relationship between DM and age. When we considered (20-39) age group as a reference category, the odds ratio of having T2DM within (40-59) age group was 12 (5.17-27.81 with 95% CI), and it was 14.43 (5.56-37.43 with 95% CI) within (60-79) age group. The majority of diabetic subjects were within (40-59) age group. Moreover, peripheral cluster subjects recorded the highest percentage of T2DM within (40-59) age group. The descriptive analysis of T2DM with cluster position and age groups is shown in table 9

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Table 8: the relationship between T2DM and BMI:

		ρ value	Odds ratio	CI (95%)	
				Lower	Upper
BMI	Normal	< 0.05	Reference		
	Overweight	< 0.05	3.21	1.29	7.96
	Obese	< 0.05	7.7	3.29	18.03

Table 9: descriptive analysis of T2DM percentages within age groups and resident place

		Age Groups			Total
		20-39	40-59	60-79	
City	Central	1 (0.5%)* (0.2%)**	2 (1.5%) (0.5%)	4 (8.1%) (1.1%)	7
	Peripheral	4 (2.2%) (1.1%)	16 (12.4%) (4.3%)	3 (6.1%) (0.8%)	23
Countryside		2 (1.1%) (0.5%)	24 (18.6%) (6.5%)	11 (22.4%) (2.9%)	37
Total		7 (3.8%) (1.9%)	42 (32.5%) (11.4%)	18 (36.7%) (4.9%)	67 (18.3%)

* Upper percentages refer to the percentages of T2DM patients within each group total subjects.
** Lower percentages refer to the percentage of T2DM patients within (20-79) age group total subjects.

While T2DM was significantly related to the story of DM among the first-degree relatives, it was not related to the story of DM among the second-degree relatives.
T2DM was significantly related to the presence of hypertension and dyslipidemia. ρ values were less than 0.05. For hypertension, OR= 5.74 (3.26-10.09 with 95% CI) and it was 7.17 (3.99-12.88) for dyslipidemia.

Unfortunately, due to unavailability to perform HDL tests, we could not define the subjects according to the metabolic syndrome MS diagnosis. However, we defined the subjects who have metabolic syndrome depending on ATP III criteria even with the absence of HDL values. The total number of participants who were diagnosed with metabolic syndrome was 101 (27.5%), and we found a significant relationship between metabolic syndrome and T2DM. ρ value was less than 0.05, and OR was 23.93 (11.9-48.14 with 95% CI) considering the normal status as a reference category.

In this research, one of the objectives was to identify the prevalence of T2DM amongst informal residential cluster families. As mentioned before, when we test the relationship between T2DM and family resident position, there was no significant relationship between the two variables. An additional variable which is not related to the participant's answer and depended on the subject concern, and hence awareness, about the medical test results. We called this variable as "the subject health concern about medical laboratory test results." Unexpectedly, when we tested the relationship between T2DM and residential place in the presence of this variable as a confounder, the insignificant value of ρ for peripheral clusters turned to be a significant ρ= 0.01<0.05 and OR= 7.41 (1.09-50.22 with 95% CI) by considering the central residency as a reference group. Moreover, when we tested the relationship between T2DM and the variable of subject's health concern, we found a significant association between T2DM and the health concern variable. When we consider the follow up of the participants to their blood test results as a reference category, ρ=0.02, and OR= 1.8 (1.01-3.21 with 95% of CI). Indeed, amongst type 2 diabetic subjects who live among informal resident places, no one of them called to ask about the blood test results.
T2DM, in this study, was not related to Gender, smoking, endogamy, marital status, or educational level.

V. Conclusion:

The overall prevalence of T2DM was 18.3% in Ar Raqqa governorate. Informal residence households tended to be diagnosed with T2DM more than central and rural families because of the low level of self-health care affected by unhealthy conditional living. The inherited unhealthy NP and low level of physical activity were contributed factors to T2DM among these families. In addition, T2DM was significantly related to BMI categories. Although the assumption that Ar Raqqa governorate has an agricultural and rural background, the obesity, nowadays, is considered as an epidemic, which confirms the accelerated impact of urbanization on Ar Raqqa population. Regardless of the role of age and informal metabolic diagnosis assessment, the obesity was determined to be the primary risk factor for T2DM development and progress. Recently, the majority of the population in Ar Raqqa started to tend toward the education even among countryside [27]. To confirm this fact, we studied the distribution of educational level among (7-19), (20-39) age groups and compared it with (40-59) age group. The percentage of illiteracy was 5%, 23.2%, 62.8% respectively. In fact, less than ten years ago, there was not any college or university in Ar Raqqa governorate. Therefore, this fact resulted in an internal migration of students from Ar Raqqa governorate to the four main Syrian cities where the 4 Syrian universities were located (Aleppo, Damascus, Homs, and Latakia). These four cities are described with high levels of urbanization comparing to Ar Raqqa governorate. Furthermore, the recent establishment of Alforat University in Ar Raqqa city led to integration between Ar Raqqa population and students who came to Ar Raqqa for education. Therefore, we can speculatively suppose that this accelerated impact of urbanization is due to the integration between people of Ar Raqqa and people from other cities. This integration is leading to unhealthy habits, nutrition patterns, and lifestyles which with the cumulative effect of the low level of concern and awareness about health will contribute to the current increase in T2DM prevalence rates.

VI. Recommendations:

Basing on these results and the background of Ar Raqqa governorate, the recommendations were set to explore the epidemiology of diabetes mellitus in Syria, and identify evidence-based and cost-effective strategies for prevention and intervention.

1- Initiate further studies and surveys to attain a better comprehension of T2DM epidemiology in Ar Raqqa governorate within the different clusters in order to clarify the current and following indicators with this regard.

2- A serious follow up has to be performed to estimate the way by which Ar Raqqa governorate is being affected by urbanization and the related consequences.

3- Establish a modernized, rational, and efficient preventive health plan to enhance the awareness and attitudes among individuals. A Supportive and cooperative setting has to be set to develop the coordination between the Ministries of Health, Education and Higher Education regarding the issue of health awareness.

4- Activate the health classes (sports classes) by the ministry of education after an appropriate clarification to the importance of these classes for youth and adults among the students and parents. It is very significant that the aspect of athletic should be improved among adults and children.

5- Further support should be undertaken by adolescent and student organizations to initiate health campaigns and raise the health awareness.

6- Besides its therapeutic role, diabetic clinics among Syria which are belonged directly to Syrian National Diabetes Program can firstly undertake a preventive role for non-diabetic individuals by awareness leaflets and booklets among the general public clinics. Secondly, a preventive role for diabetic patients can be undertaken to restrict DM consequences by distributing booklets for medical information about follow up and prevention of DM.

7- Determine to which level we can generalize the results, conclusion, and recommendations of this study on the other governorates.

VII. Limitations:

This research contained several limitations which were out of the researcher control. Indeed, the diagnosis of metabolic syndrome was not determined because HDL test was not performed because it was not available through the central laboratory in Ar Raqqa National Hospital. The time constriction was a critical issue which led to an over in the number of daily visits 3-4 visits, and some visits took place in the early morning. Additionally, sometimes we faced withdrawn subjects who could not wait because of commitment to jobs and carriers, and who could not fast for 8 to 10 hours.

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